MUTUAL EFFECTS OF CONDITIONING TO PHYSICAL LOADS AND ADAPTATION TO HYPOXIC HYPOXIA

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ABSTRACT: This research was conducted on white rats. The animals were conditioned in running on a treadmill under ordinary atmospheric conditions under middle-altitude conditions (altitude of 2000 m) and under atmospheric conditions with parallel interrupted adaptation of the rats to hypoxia under pressure-chamber conditions (altitude of 3000 - 7000 m). We studied the change in weight of the animals, the number of erythrocytes, amount of hemoglobin and life time of the animals under conditions of acute hypoxia.

It was established that the isolated effect of only one conditioning to physical loads and even the parallel effect of conditioning to physical loads and adaptation to hypoxia did not lead to an increase in the tolerance of acute hypoxia. An increase was observed only with conditioning under middle-altitude conditions.

The question concerning the mutual effect of conditioning to physical loads and adaptation to hypoxia in spite of the multitude of research remains debatable (see in the present collection the article by Ye.V. Loginovaya, "Tolerance of Animals to Acute Hypoxia After Conditioning to Physical Loads Under High-Altitude Conditions").

In the first report data are cited which indicate the possibility of cumulation of changes associated with the physical load and a moderate degree of hypoxia with their simultaneous effects. /94

In this paper we have changed somewhat the conditions of the experiment. Conditioning to physical loads was carried out, not with an oxygen deficiency, but under ordinary laboratory conditions in which case these animals were adapted to hypoxia and in parallel under pressure-chamber conditions.

The experiment was carried out on 44 white rats who were divided into 4 groups:

Group 1: 12 rats subjected to interrupted pressure-chamber adaptation and parallely to conditioning to dynamic loads on a

treadmill;

Group 2: 12 animals who were conditioned only to dynamic loads;

Group 3: this group consisted of 10 rats adapted to hypoxia under pressure-chamber conditions;

Group 4: a control group kept under the conditions of the vivarium in Moscow.

Interrupted adaptation to hypoxia in a pressure chamber was carried out for a period of 13 days with a constant increase in "altitude" from 3000 to 7000 m. The daily time spent by the animals at this "altitude" was 6 hours $\pm$ 20 minutes. During this time the chamber was continuously ventilated so that the CO_2 did not exceed 1%, the humidity 60-80% and the temperature 23-25° C. We carried out this interrupted adaptation since it is highly effective and permits us to carry out a parallel conditioning to physical loads.

Conditioning to physical loads was carried out each day in a special treadmill. The rate of running of the animals was maintained constant 36 m/min. The load was increased with each conditioning cycle because of the increase in the path by 6 m. Altogether 14 conditioning exercises were carried out. This conditioning schedule was proven by us in the expedition to Mount Elbrus where it gave positive results.

Regularly in all of the animals before, during and after the conditioning cycle, we determined the weight, amount of hemoglobin, number of crythrocytes, reticulocytes and eosinophils in the peripheral blood. The blood was taken from a cut at the end of the tail.

After ending the conditioning in all groups of animals we determined the lifetime under conditions of gradual "ascent" in a pressure chamber. The rats "ascended" at a rate of 75-80 m/sec to the "altitude" at which they died. The first ten minutes "rest" was at 11,000 m, then 5-minute rests were repeated every 1000 m.

Adaptation of the animals to hypoxia was accompanied by an increase in the number of erythrocytes in the hemoglobin and a lag in the weight of the rat (Table 1).

Conditioning of the animals to dynamic loads produced a slight increase in the number of erythrocytes and a statistically valid increase in the hemoglobin in comparison with unconditioned animals./95

The increase in the number of erythrocytes with the parallel effect of conditioning to hypoxia and to dynamic loads was the same as in animals subjected only to adaptation to hypoxia. The amount of hemoglobin in these animals was slightly higher than in those who were only adapted ($P>0.01$).

TABLE 1. CHANGES IN THE NUMBER OF ERYTHROCYTES, HEMOGLOBIN AND WEIGHT IN DIFFERENT GROUPS OF ANIMALS BEFORE, DURING AND AFTER ADAPTATION TO HYPOXIA AND CONDITIONING IN RUNNING.

Group	7th day after beginning	3rd day end of effect	Group	7th day after beginning	3rd day end of effect	Group	Before effect	3rd day end of effect
	M	M		M	M		M	M
	Erythrocytes, 1000/lcm^3			Hemoglobin, g%			Weight, g	
DA	5726	6727	DA	14.8	17.8	DA	152	158
DC	5638	5570	DC	14.5	13.9	DC	152	166
A	5642	6540	A	14.2	16.4	A	152	168
C	4960	5000	C	13.1	11.8	C	152	204

Comment: DA are the dynamically adapted animals who have been parallely conditioned to muscular loads and adapted to hypoxia; DC is the dynamic control group of animals who have been conditioned only to dynamic loads; A are the adapted animals who have been adapted only to hypoxia; C is the control group of rats kept under conditions of the vivarium in Moscow.

The number of reticulocytes in the conditioned animals was the same as in the unconditioned animals. Changes in the red blood show that the physical load which we selected was average weight. The heavy physical work caused a decrease in the number of erythrocytes and hemoglobin in the peripheral blood and was accompanied by an increase in the number of reticulocytes.

The number of eosinophils in all groups was almost identical. In animals kept under conditions of the vivarium, somewhat higher numbers were observed but the differences were statistically unreliable.

The weight of the animals subjected both to conditioning only to one of these factors studied by us and those subjected parallelly to both varied identically. All the groups of animals lagged in weight from the control group by 30-40 grams. The differences between the three groups were statistically unreliable. The differences of each of these groups from the fourth are reliable. /96

Thus, conditioning to dynamic loads just as adaptation to hypoxia produced changes in the red blood and a lag in weight of the animals. In spite of the single direction of the changes of the characteristics which we studied, conditioning to dynamic loads gave no increase in tolerance of the rats to acute hypoxia (Table 2).

TABLE 2. LIFETIME OF DIFFERENT GROUPS OF ANIMALS UNDER CONDITIONS OF ACUTE HYPOXIA.

Group *	M, min	P	Group *	M, min	P
DA	12.3	>0.01			
D	6.5	< 0.5	A	15.2	< 0.5
C	7.9	>0.01	DA	12.3	
A	15.2				

* The designations are the same as in Table 1.

As follows from this table the conditioning of animals to dynamic loads not only did not increase the ifetime of the animals at "high altitude", but even lowered it slightly.

The decr ase of thid characteristic was noted both in animals who were conditioned only to dynamic loads in comparison with the control group and in animals who were subjected to the parallel effect of the two factors in comparison with animals who were adapted only to hypoxia.

In conclusion we can say that it is not in all cases that conditioning to physical loads is accompanied by an increase in the tolerance of an organiam to hypoxia. Such an increase was observed with the simultaneous effect of conditioning and adaptation; the isolated effect of only one conditioning to physical loads and even the parallel effect of two of these factors did not lead to an increase in the tolerance of the organism to hypoxia.